How to do equine anaesthesia in the field

Introduction

Anaesthesia in the field is commonly performed in equine practice for short, minor surgical procedures. and is a vital skill for equine clinicians. This article will focus on the practicalities of the how to perform general anaesthesia of horses in the field setting in a safe manner.

Standing Sedation vs General Anaesthesia

General anaesthesia in horses carries an inherent risk (Johnston et al., 2002). Therefore, many surgical procedures are performed in the standing sedated horse, combined with local anaesthesia. Selection of cases that require general anaesthesia in preference tosedation involves: individual assessment of the procedure to be performed; the temperament of the horse; available facilities and number of trained personnel. The same due consideration for the safety of the handler and veterinarian should be given to the decision to perform surgery on the standing sedated horse whether outside or within the clinic setting. Without stocks for restraint sedated horses may move during the procedure and may pose a risk to the surgeon if roused by surgical stimulation. Techniques for ‘field anaesthesia’ can also be employed in the ambulatory clinic setting where an anaesthetic machine is not available but a padded stable is prepared for induction and recovery.

Location, Location, Location

Before performing anaesthesia in the field always check that a suitable location is available. Induction and recovery from general anaesthesia can pose a significant risk to both the horse and the handler. A large, well surfaced indoor school that has had all obstacles removed may be suitable though consideration should be given to the flooring substrate. Loose, particulate substrates such as sand, sawdust and woodchip can get into eyes and wounds and have the

potential to be inhaled via the end of the endotracheal tube. Alternatively a flat, obstacle free and well grassed field may be appropriate. The area should be free of rocks, rabbit holes and farm equipment. Areas close to running water, ditches, close to busy roads and at the top / bottom of a slope are not appropriate. Recovery from anaesthesia in an enclosed stable risks at least minor injury to the horse. If a stable is to be used a deep bed should be provided and the building must be structurally sound.

Personnel

It is advised that a second vet or a registered veterinary nurse accompanies the veterinary surgeon when a field anaesthetic is planned As it may be difficult to perform surgery whilst monitoring the horse closely. A trained veterinary nurse is able to monitor the depth of anaesthesia and administer additional anaesthetic agent under the direction of the veterinary surgeon. If an assistant is unavailable then a stopwatch is a good way to keep check on the duration of anaesthesia to remind the veterinary surgeon when it is time to closely assess the depth of anaesthesia with a view to the horse potentially requiring additional anaesthetic drugs.

Equipment

A list of equipment required for anaesthesia in the field can be found in Table 1. ‘Off the needle’ injections are not advised as horses can move unexpectedly during anaesthesia, attempting an intravenous (i.v). injection in this instance is challenging and dangerous. An i.v. catheter with an easily accessible extension port should be placed, either before or after the horse is sedated. It is a good idea to have endotracheal tubes available; a range of sizes from18mm to 28mm should fit most horses and ponies though smaller sizes may be required in small breeds of pony or for foals. Provision of oxygen is recommended for all but the shortest of procedures, as recumbency alone induces a component of ventilation/perfusion

mismatch in the lung with consequent hypoxaemia. It may also be necessary to ventilate the horses lungs ifhypoventilation or apnoea occurs following induction of anaesthesia, after administration of a "top-up" dose of anaesthetic or in emergency situations. Small CD sized cylinders (Photo 1) are lightweight with a capacity of 460L of oxygen. The Shrader connection means that they can be easily fitted with an Equine Demand Valve (EDV) (Oxygen Demand Valve –Equine, Eickemeyer Veterinary Equipment LTD, Surrey, UK). The EDV provides 160L/min oxygen at the push of a button. The transport of compressed oxygen cylinders in cars is covered by The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (SI 58) with basic legal safety requirements that veterinary surgeons should be aware of and adhere to when carrying oxygen cylinders. A padded, well fitting headcollar along with ropes and lunge lines are required for control during induction and recovery, along with a towel to cover the eyes.

Ancillary Equipment	Stop watch Anaesthetic record card and pen Consent form Needles and syringes Fluid administration sets
Catheter Equipment	Clippers Chlorhexidine / Isopropyl alcohol scrub Local anaesthetic Suture material / Superglue Catheters Needle-free injection port Saline Flush

Induction	Padded head collar Lead ropes / lunge lines
Maintenance	Towel and lubrication for the eyes Endotracheal tube Oxygen cylinder Demand valve
Drugs	Acepromazine α2-adrenoceptor agonist Opioid Ketamine Benzodiazepine Guaifenesin Non-steroidal anti-inflammatory drug Tetanus antitoxin Antimicrobial Hartmanns Solution (5L)

Table 1: Equipment required for general anaesthesia of a horse in the field setting

Pre-Anaesthetic Examination

As with any general anaesthetic all patients should have a thorough physical examination performed and informed owner consent should be obtained. If castration is planned, and the horse is amenable to examination of the area, the presence of testes within the scrotum should be confirmed; identifying a retained testicle prior to anaesthesia will save time and embarrassment later. Until further evidence is available in horses that are “trickle-feeders”the owner should be asked to withold food for 2-4 hours and allow free access to water before

anaesthesia. Some texts advise withholding food for up to 12 hours and, although it's wise to prevent the horse gorging on hay or grass or having a large meal of concentrates in this time, preventing access to all food may be stressful for the animal. It is worth asking a farrier to either trim the feet or remove the shoes to reduce the likelihood of the animal injuring itself or the operators. If the horse is shod the clenches can be covered with Elastoplast to stop accidental trauma during induction and recovery.If the trachea is going to be intubated the mouth should be washed out to prevent aspiration of food material or inadvertent transfer of it into In most circumstances electronic weigh scales will not be available so the horse's weight should be estimated using a weigh tape. An appropriate antimicrobial and tetanus antitoxin should also be administered if required.

Sedation

The route of administration and choice of sedative drugs will depend upon the temperament of the horse, the procedure to be performed and also the individual veterinary surgeons preferences (Table 2). It may be easier to place a jugular catheter and prepare the horse for anaesthesia and surgery following sedation. If the horse's temperament precludes prior examination and catheter placement then intramuscular (i.m.) injection with a combination of acepromazine/detomidine/morphine using a prefilled extension line is advised, a syringe with a secure luer lock connector will prevent inadvertent disconnection during injection (Photo 2). Acepromazine is commonly used prior to general anaesthesia due to the associated reduction in perioperative equine mortality (Johnston et al., 2002). The risk of priapism in males should be considered, though the incidence of permanent penile dysfunction is reported to be less than 1 in 10,000 (Driessen et al., 2011). If an α2-adrenoceptor agonist is to be used during the maintenance phase of anaesthesia (eg in a "triple drip") then either that drug or xylazine is often chosen (due to its shorter duration of action). The pharmacokinetic profile of the newer α2-adrenoceptor agonist dexmedetomidine would make it a good choice for field

anaesthesia (Bettschart-Wolfensberger et al., 1999) but it is currently not licensed for use in horses. It is a good idea to position the horse in the area chosen for induction of anaesthesia before administration of the α2-adrenoceptor agonist since moving a sedated horse can be challenging (or even impossible) and will rouse the horse from sedation.

Analgesia

Provision of analgesia that covers the surgical but also postoperative period is important as these horses may not have veterinary supervision beyond the recovery from anaesthesia. Non-steroidal anti-inflammatory drugs (NSAIDs) remain the mainstay of postoperative analgesia due to their ease of owner administration and long duration of action. NSAIDs should be givenbefore surgery – "pre-emptive analgesia".

An opioid should be given once the horse is sedated or after induction of anaesthesia. Despite their beneficial analgesic properties the use of opioids during equine anaesthesia is still limited (Wohlfender et al., 2015). Morphine, buprenorphine or butorphanol can be used with the selection of drug based on the invasiveness of the planned procedure and adherence to the legally obligations for record keeping and drug storage requirements. Morphine is associated with quicker times to standing and fewer attempts to stand (Clark et al., 2008), but the longer duration of action of buprenorphine may be beneficial in a setting where an ongoing veterinary presence in the postoperative period is not possible. Buprenorphine provided good sedation, induction and recovery scores when used for castration of colts under field conditions (Love et al., 2013) and may provide better postoperative analgesia than butorphanol.

Infiltration of local anaesthetic is easy to perform and provides analgesia not just for the procedure but also into the postoperative period. Use of local anaesthetic injected into the testicle, cord and subcutaneously is fairly routine for standing castration, the same should be

performed for anaesthetised horses. Anaesthetised horses that have lidocaine infused before castration are less likely to move and require fewer top-ups of anaesthetic agent (Portier et al., 2009).

Drug	**Route of Administration**	**Dose**	**Duration of sedation**	**Duration of Analgesia**
Acepromazine	IM / IV	0.01-0.05mg/kg	4-6 hours IM 1-2 hours IV	none
Xylazine	IV	0.5 - 1.1mg/kg	30 minutes	20 minutes
Detomidine	IV	0.01-0.02mg/kg	1 hour	45 minutes
Romifidine	IV	0.08-0.12 mg/kg	60 minutes	0.5-3hours
Butorphanol	IV	0.02-0.05 mg/kg		1 hour
Buprenorphine	IV	0.01mg/kg		2+ hours
Morphine	IV	0.1-0.2mg/kg		2-4 hours
Detomidine/ Morphine/ Acepromazine	IM combination for horse hard to handle	0.04mg/kg 0.3mg/kg 0.04mg/kg		

Table 2; Dose of commonly used drugs for sedation of horses prior to general anaesthesia

Induction

Once appropriately sedated the horse should stand square, with a low head carriage, a loose lower lip and show minimal response to sound (Photo 3). Familiarity with induction of anaesthesia makes the process smoother. Ropes should be attached to the head collar and two trained people should stand on either side of the horse. One hand should hold the head collar

or lead rope and the other hand rests gently on the horses shoulder. Horses respond to pressure by leaning towards it so it is important not start pushing the horse backwards too early during induction of anaesthesia as they will move towards the pressure and potentially fall forwards. The aim of the handlers should be to try to guide the horse backwards when they start to become recumbent and to control the head to prevent it being traumatised on the ground. An experienced equine vet may be able to handle smaller horses and ponies for induction of anaesthesia by themselves. It's important to have good situational awareness and the ability to react quickly if things do not go to plan.

Induction doses of commonly used anaesthetic agents for administration after an alpha-2 adrenoreceptor agonist can be found in Table 3. It is vital to clearly label syringes to prevent accidental administration of ketamine when flushing catheters. It is also important to draw up and clearly label supplemental doses of an anaesthetic for administration as a "top-up" before anaesthesia is induced. The time to recumbency is longer after administration of a dissociative agent such as ketamine than after barbiturates or alfaxalone In equine practice the most commonly used anaesthetic is combination of ketamine and diazepam (Wohlfender et al., 2015); the use of a benzodiazepine such as diazepam or midazolam improves induction quality, ease of intubation and surgical conditions but without negatively impacting on cardiovascular parameters and recovery quality (Allison et al., 2016). Hypnotic agents such as sodium thiopental produce a more rapid induction of general anaesthesia than ketamine with the horse often lifting its head at induction; the head should be controlled to stop the horse losing its balance and falling. In the UK a preparation of sodium thiopental with a veterinary marketing authorisation is not currently available and thus its use is restricted. Propofol and alfaxalone are also available though do not have marketing authorisations for administration to horses.. In horses propofol is not suitable for induction of anaesthesia alone, alfaxalone in combination with midazolam produces a calm controlled induction. Induction

techniques that incorporate guaifenesin can be used though ataxia during induction of anaesthesia can be problematic in field sitations.

Once anaesthesia is induced the trachea can now be intubated if desired and inspired oxygen supplemented. It is recommended that oxygen is provided for any procedure lasting longer than 20 minutes (Taylor and Clarke, 2008). Blood pressure is usually well maintained with injectable protocols in comparison to inhalational anaesthesia (McMurphy et al., 2002). The horse should be appropriately positioned with the lower forelimb pulled forwards and the lower hind limb extended backwards. If a castration is to be performed a rope is placed around the pastern of the upper hind limb and the leg flexed out of the surgical field. A towel is often placed over the horses eyes to reduce light stimulation, a blindfold or blinkers are not recommended as these cannot be removed quickly. Sometimes the ears may be packed to reduce noise stimulation, if this is too be done then the packaging must be easily removed and be of a material that does not break apart easily leaving pieces within the ears. The eyes should have lubrication applied and the head can be positioned on a towel or cushion to prevent corneal damage andpossible ulceration.

Drug / Combination	**Dose**
Ketamine	2.6-3mg/kg
Ketamine + Midazolam or Diazepam	2.2mg/kg (if weight known) 2.5-3mg/kg (if weight estimated) 0.05mg/kg
Thiopental	7mg/kg
Thiopental + Guaifenesin	5 mg/kg 25-75 mg/kg
Alfaxalone +	1 mg/kg

Midazolam or Diazepam	0.05mg/kg

Table 3; Dose of drugs commonly used for the induction of general anaesthesia after α_2-adrenoreceptor agonist pre-medication in horses in the field setting

Monitoring

Monitoring of the respiratory rate, pattern and effort are crucial to identify early signs of respiratory tract obstruction. Palpation of a pulse, both rate and strength, is vital so that cardiovascular failure is not missed. Portable pulse oximeters allow the pulse rate and saturation of haemoglobin with oxygen to be monitored (Photo 4) although these are often unreliable in horses due to the thickness of the tongue. In comparison to volatile anaesthesia cranial nerve reflexes are preserved and the eye remains in a central position. Depth of anaesthesia is assessed using changes in respiratory rate and depth, lacrimation, palpebral reflex and nystagmus. Horses at a very light plane of anaesthesia will have rapid nystagmus, may swallow spontaneously and may move. Clearly labelled and easily accessible edrugs for administration in the event of an emergency should be available in every case.**Total Intravenous Anaesthesia (TIVA)**

Two main methods exist for the use of TIVA to maintain anaesthesia in the field, colloquially referred to as ‘top-ups’ or ‘triple-drip’. Diagram 1 contains dose and administration rates for maintenance of field anaesthesia. Intermittent administration of anaesthetic agents has the disadvantage of peaks and troughs in drug plasma concentrationswhich can lead to a variable depth of anaesthesia. that at times the plasma concentration is outside of the therapeutic range resulting in inadequate depths of anaesthesia. Giving smaller and more frequent doses of anaesthetic agentis one way to attempt to minimise the variability within the plasma concentrations. Continuous administration of a drug should result in a more stable plasma concentration.

"Top-Up" Technique

Using the "top-up" technique additional injections of anaesthetic agent are given at set intervals to prolong the effect. This is suitable for short to medium duration procedures not exceeding 40 minutes. Combinations of ketamine and α_2-adrenoreceptor agonists are usually used. The short onset time of xylazine makes it attractive for use in this way though it is possible to use detomidine or romifidine. Commonly half to a third of the original doses of ketamine and xylazine are administeredafter 10 minutes of anaesthesia and subsequent top-ups at 10 minute intervals can be a quarter to a third of the original doses to avoid accumulation of drugs. More experienced veterinary surgeons may choose to administer "top-ups" when they feel that they are required (an this may be nearer 15-20 minute intervals) though since ketamine and xylazine take a few minutes to exert their peak effect confidence in assessing depth of anaesthesia is required; waiting until the horse is very "light" may result in movement which can be dangerous. During the maintenance phase the total dose of ketamine given should not exceed twice the induction dose of ketamine or ataxia on recovery may be apparent. Recoveries following this technique are often smooth but may be abrupt.

Triple-Drip

This technique uses the combination of guaifenesin, an α_2-adrenoreceptor agonist and ketamine. The most commonly used combination used is guaifenesin/xylazine/ketamine; this was first reported in 1986 (Greene et al., 1986). A commercial preparation of 10% guaifenesin (Myorelax; Dechra, Shrewsbury, UK) is available and ketamine and xylazine are added to the bottle (Photo 5). For ease of administration a drip line with an air intake valve or a needle pushed into the top of the bottle is required. The duration of infusion should not exceed 90 minutes as accumulation of guaifenesin may lead to a prolonged and ataxic recovery from anaesthesia (Taylor et al., 1992). Induction of anaesthesia is usually performed

with a standard combination of ketamine and benzodiazepine rather than guaifenesin and ketamine and the 'triple-drip' is started for the maintenance phase; this avoid large total doses of guaifenesin which would be administered if it was used both for induction and maintenance of anaesthesia. Guaifenesin is irritant to the vascular endothelium and also if it is administered perivascularly so it is very important that a secure intravenous catheter is placed and it's patency is checked before administration of guaifenesin. It is also important to flush the catheter with a large volume of saline before removal to prevent deposition of the drug within the wall of the jugular vein upon catheter removal as this could cause thrombophlebitis.

Continuous Rate Infusions (CRIs)

The hypnotic anaesthetic agents propofol and alfaxalone have both been used for the maintenance of general anaesthesia in horses though neither have a marketing authorisation nor are their use recommended at present.

Recovery

Additional sedation is not usually required for recovery after short periods of anaesthesia. The horse should be positioned in lateral recumbency with the dependent limb pulled forwards. Headcollars should be padded and care should be taken to reduce pressure on the facial nerve from buckles and restraint techniques since facial nerve paralysis is a potential complication. External stimuli should be kept to a minimum to try to prevent the horse attempting to stand prematurely. If the horses attempts to stand too soon it may be ataxic. If it is safe to do so administering sedation may prolong the period of recumbency. If the horse continues to make attempts to stand then it may be restrained in lateral recumbency by kneeling on the horses neck with pressure applied at the level of the atlanto-axial joint. The mandible should be held firmly and the head pulled in a dorsal and lateral direction. This

stops the horse making the normal head movement to allow them to stand. Once the horse has calmed or is stronger the pressure can be removed and the horse allowed to stand. The size and temperament of the horse and the strength of the veterinary surgeon should be considered when deciding whether to attempt restraining a horse in lateral recumbency and the safety of people should be paramount. Most horses will stand within 20-40 minutes of the end of field anaesthesia. Enough time should be allowed for the veterinarian to stay for the entire recovery period.

Post-Operative Care

Once recovered from anaesthesia careful instructions must be left with the owners for what to monitor and what medication should be administered. Explanation of the subtle signs of pain should be made. A recent editorial highlighted the importance of unresolved stress and pain behaviour on the welfare of horses (Horseman, 2017).

Emergency Field Anaesthesia

Occasionally it may be necessary to anaesthetise horses that have become trapped in a stable or ditch, have been involved in a road traffic accident or have been injured during exercise. It should be remembered that in these situations human safety must take priority. Care should be taken to not become trapped between the horse and other objects or to find yourself positioned between the horse's limbs. Exhaustion and stress add additional challenges due to changes in metabolic rate and cardiovascular and respiratory function. High levels of circulating catecholamines can reduce the effectiveness of α_2- adrenoreceptor agonists so higher than normal doses may need to be administered. However, the animals physiological state should be carefully considered and horses that have suffered from severe haemorrhage or who are debilitated may need more conservative doses of α_2- adrenoreceptor agonists. The use of long prefilled extension lines attached to a syringe allow i.m. injection from a distance.

Induction of general anaesthesia may be required for removal of trapped horses by the emergency services. Once the horse has been removed from the immediate danger attention should be paid to where the horse will recover. It may be necessary to extend the period of anaesthesia to move the horse a second time to a safe place. In these situations you should be satisfied that the horse is well sedated or anaesthetised before allowing the emergency services to approach. Appropriate training for large animal rescue can be obtained via the BEVA (www.beva.org.uk) and the British Animal Rescue & Trauma Care Association (bartacic.org).

Summary

Field anaesthesia requires the same preparation and expertise as anaesthesia in the clinic or hospital setting. Selection of an appropriate area for performance of anaesthesia and careful consideration of the anaesthetic protocol / technique to be used, are essential for a good outcome.

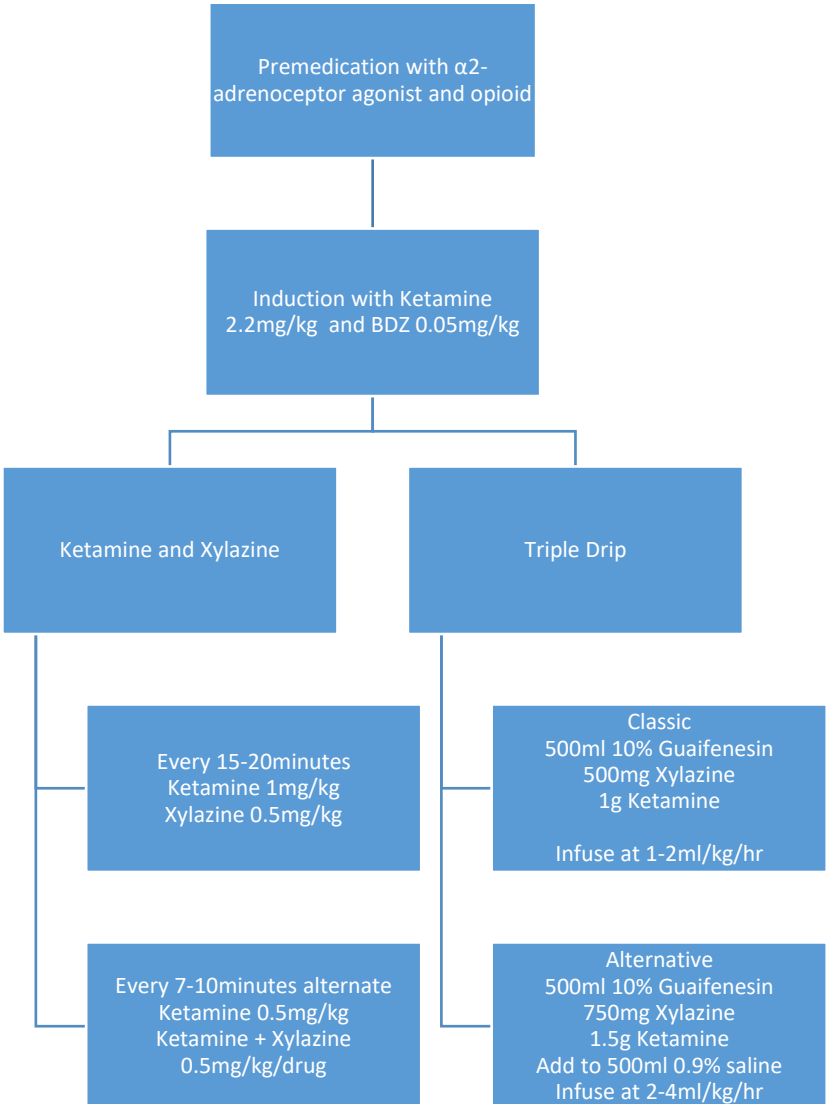

Diagram 1; Equine Field Anaesthesia Dosage and Infusion Rates

Photo 1; CD Oxygen cylinder with Shrader connection and Equine Demand Valve

Photo 2; Long line for intramuscular injection

Photo 3; Horse following sedation showing appropriate stance and drooping of the lower lip and ears

Photo 4; Portable pulse oximeter suitable for field anaesthesia

Photo 5; Triple drip combination using commercially available 10% guaifenesin preparation

ALLISON, A., ROBINSON, R., JOLLIFFE, C. & TAYLOR, P. M. Evaluation of the use of midazolam as a co-induction agent with ketamine for anaesthesia in healthy, sedated ponies undergoing field castration. Association of Veterinary Anaesthetists Autumn Meeting, 2016 Prague. 68.

BETTSCHART-WOLFENSBERGER, R., CLARKE, K. W., VAINIO, O., ALIABADI, F. S. & DEMUTH, D. 1999. Pharmacokinetics of medetomidine in ponies and elaboration of a medetomidine infusion regime which provides a constant level of sedation. *Research in Veterinary Science,* 67**,** 41-46.

CLARK, L., CLUTTON, R. E., BLISSITT, K. J. & CHASE-TOPPING, M. E. 2008. The effects of morphine on the recovery of horses from halothane anaesthesia. *Veterinary Anaesthesia and Analgesia,* 35**,** 22-29.

DRIESSEN, B., ZARUCCO, L., KALIR, B. & BERTOLOTTI, L. 2011. Contemporary use of acepromazine in the anaesthetic management of male horses and ponies: A retrospective study and opinion poll. *Equine Veterinary Journal,* 43**,** 88-98.

GREENE, S. A., THURMON, J. C., TRANQUILLI, W. J. & BENSON, G. J. 1986. Cardiopulmonary Effects of Continuous Intravenous-Infusion of Guaifenesin, Ketamine, and Xylazine in Ponies. *American Journal of Veterinary Research,* 47**,** 2364-2367.

HORSEMAN, S. 2017. The four priority welfare challenges. *Equine Veterinary Education,* Early View.

JOHNSTON, G. M., EASTMENT, J. K., WOOD, J. L. N. & TAYLOR, P. M. 2002. The confidential enquiry into perioperative equine fatalities (CEPEF): mortality results of Phases 1 and 2. *Veterinary Anaesthesia and Analgesia,* 29**,** 159-170.

LOVE, E. J., TAYLOR, P. M., WHAY, H. R. & MURRELL, J. 2013. Postcastration analgesia in ponies using buprenorphine hydrochloride. *Veterinary Record,* 172**,** 635-+.

MCMURPHY, R. M., YOUNG, L. E., MARLIN, D. J. & WALSH, K. 2002. Comparison of the cardiopulmonary effects of anesthesia maintained by continuous infusion of romifidine, guaifenesin, and ketamine with anesthesia maintained by inhalation of halothane in horses. *American Journal of Veterinary Research,* 63**,** 1655-1661.

PORTIER, K. G., JAILLARDON, L., LEECE, E. A. & WALSH, C. M. 2009. Castration of horses under total intravenous anaesthesia: analgesic effects of lidocaine. *Veterinary Anaesthesia and Analgesia,* 36**,** 173-179.

TAYLOR, P. M. & CLARKE, K. W. 2008. Handbook of Equine Anaesthesia. Second ed.: Saunders Elsevier.

TAYLOR, P. M., LUNA, S. P. L., BREARLEY, J. C., YOUNG, S. S. & JOHNSON, C. B. 1992. Physiological effects of total intravenous surgical anaesthesia using detomidine-guaiphenesin-ketamine in horses *Journal of Veterinary Anaesthesia,* 19**,** 24-31.

WOHLFENDER, F. D., DOHERR, M. G., DRIESSEN, B., HARTNACK, S., JOHNSTON, G. M. & BETTSCHART-WOLFENSBERGER, R. 2015. International online survey to assess current practice in equine anaesthesia. *Equine Veterinary Journal,* 47**,** 65-71.

YOUNG, L. E., BARTRAM, D. H., DIAMOND, M. J., GREGG, A. S. & JONES, R. S. 1993. Clinical evaluation of an infusion of xylazine, guaifenesin and ketamine for maintenance of anaesthesia in horses. *Equine Vet J,* 25**,** 115-9.

Further Reading

GLEERUP, K. B. & LINDEGAARD, C. 2016. Recognition and quantification of pain in horses: A tutorial review. Equine Veterinary Education, 28, 47-57

330 HORSEMAN, S. 2017. The four priority welfare challenges. Equine Veterinary Education,
331 Early View

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